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PARK LAKE DAM

MANUAL FOR OPERATION AND MAINTENANCE

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1420 East Sixth Avenue
Helena, MT 59620**

**Initial Publication November 1999
Revised November 2003**

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PROJECT DESCRIPTION

OVERVIEW

Park Lake Dam is located in a small tributary drainage above Lump Gulch in Jefferson County, approximately 20 miles southwest of Helena, Montana (see Figures 1 and 2). Figure 3 provides a general layout of the dam and spillway. Figure 4 provides a monitoring wells locations map.

The dam is owned and managed by the Montana Department of Fish, Wildlife and Parks (DFWP). The dam and reservoir are principally located on DFWP land, although some of the East Dike may be located on US Forest Service land. The DNRC State Water Projects Bureau (SWPB) inspects the dam annually and provides engineering assistance as needed.

The reservoir has a capacity of 389 acre-feet at the principal spillway crest and a capacity of 701 acre-feet at dam crest. The reservoir is used primarily for water-based public recreation and as a fishery water supply.

SUPPLY CANAL

Water is diverted from Lump Gulch to the reservoir by a 1.2 mile long supply canal. The diversion structure for the canal consists of a timber headgate structure located in the left abutment of an earthen dam in Lump Gulch near Frohner Meadows. The volume entering the ditch is controlled by stop-boards at the diversion structure. The water delivered by the canal in the spring and early summer is used to maintain the pool level throughout the summer.

The canal is currently in fairly poor condition, and can only handle 5 to 10 cfs. The capacity could be increased substantially

with additional work to possibly 30 cfs.

The Park Lake diversion dam located on Lump gulch in the NE ¼ of Section 23, T8N, R5W impounds less than 50 acre-feet. The embankment is approximately 220 feet long and 8.8 feet high. The right embankment (looking downstream) adjacent to the wooden diversion structure has eroded behind a protective concrete surface and will not allow significant water storage.

EMBANKMENT

Park Lake includes a "Main Dam" located on the south side of the reservoir and a series of smaller dams (the "East Dike") along the east side of the reservoir. The Park Lake dam and dikes were built in 1871 or 1872 to raise the level of an existing mountain lake as part of the Park Ditch Project which was used to supply water to mining operations in the gulches above Helena.

The "Main Dam" is about 22 feet high and has a crest length of 350 feet. The crest of the dam varies from 10 to 25 feet and is narrowest toward the right (west) abutment. There is no upstream rip-rap slope protection which has resulted in severe scarping (8 to 10 feet) of the upstream face due to wave erosion. The downstream slope of the dam is uneven, and relatively steep. Both the embankment crest and downstream slope are completely covered with mature coniferous trees.

The "East Dike" consists of a connected series of small dikes and natural ground along the alignment of the gravel access road. Fill heights along this 2000 foot stretch of road vary from 0 to 18.5 feet, and the crest width varies from 25 to 30 feet. The upstream slope of the dike does not have any slope protection, and scraping has resulted (4 to 6 feet). The upstream and downstream slope are variably covered by grasses, brush and mature coniferous trees.

OUTLET WORKS

Historically water was released from the reservoir to supply water for mining operations. The remnants of a canal are visible at the toe of the main dam, however no evidence of a low-level outlet structure exists.

SPILLWAY

The dam's primary spillway consists of a 57" x 38" metal pipe-arch culvert through the south end of the East Dike. The culvert is 53 feet long. The capacity of the culvert with the reservoir at the emergency spillway crest is approximately 109 cfs.

A de-facto emergency spillway exists in the parking area at the southeast corner of the lake. The crest elevation of the parking area is approximately 1.5 feet lower than the crest elevation of the main dam.

DRAINS

There are no known drains in the Main Dam embankment or the East Dike.



4

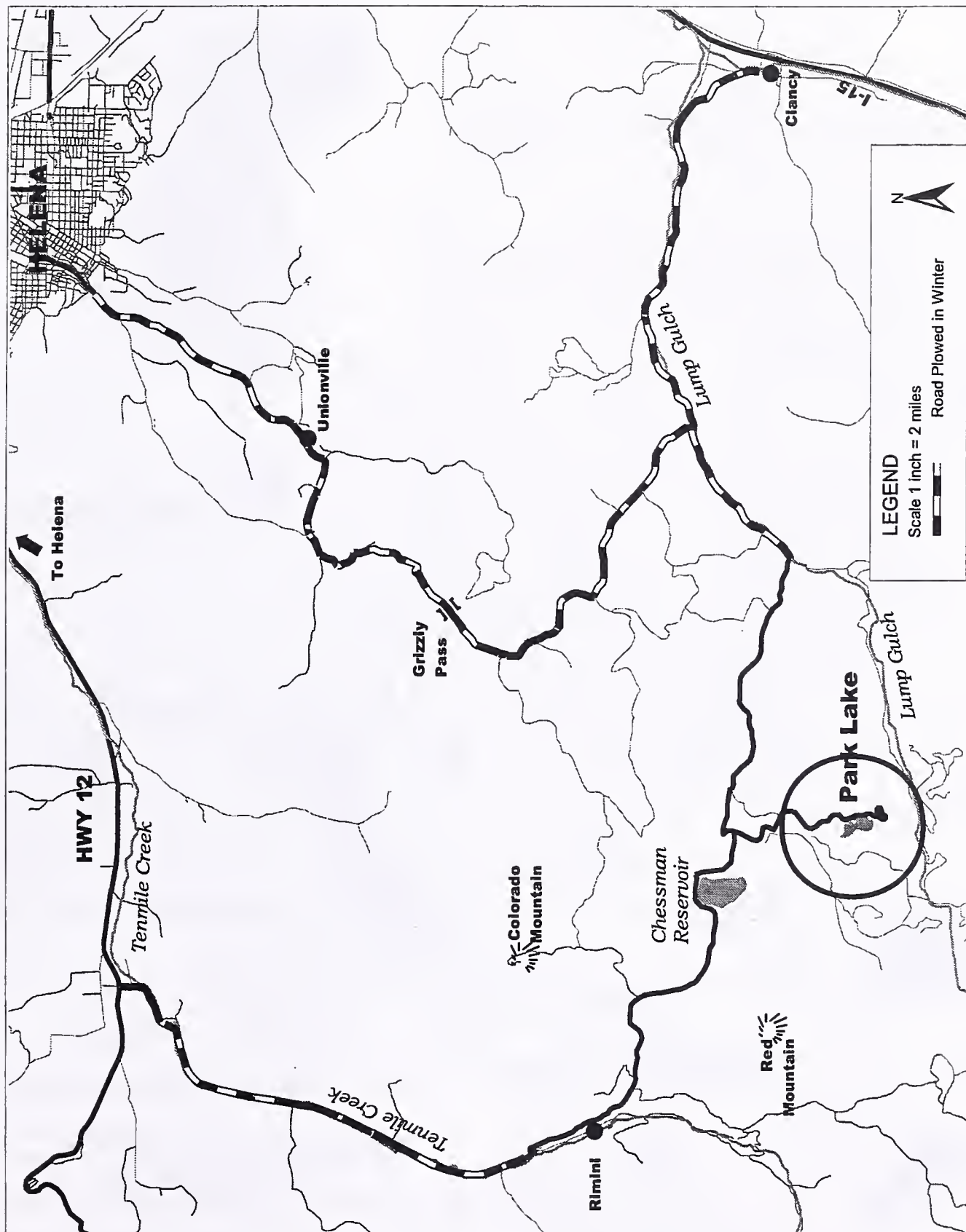


Figure 2. Park Lake Access Routes

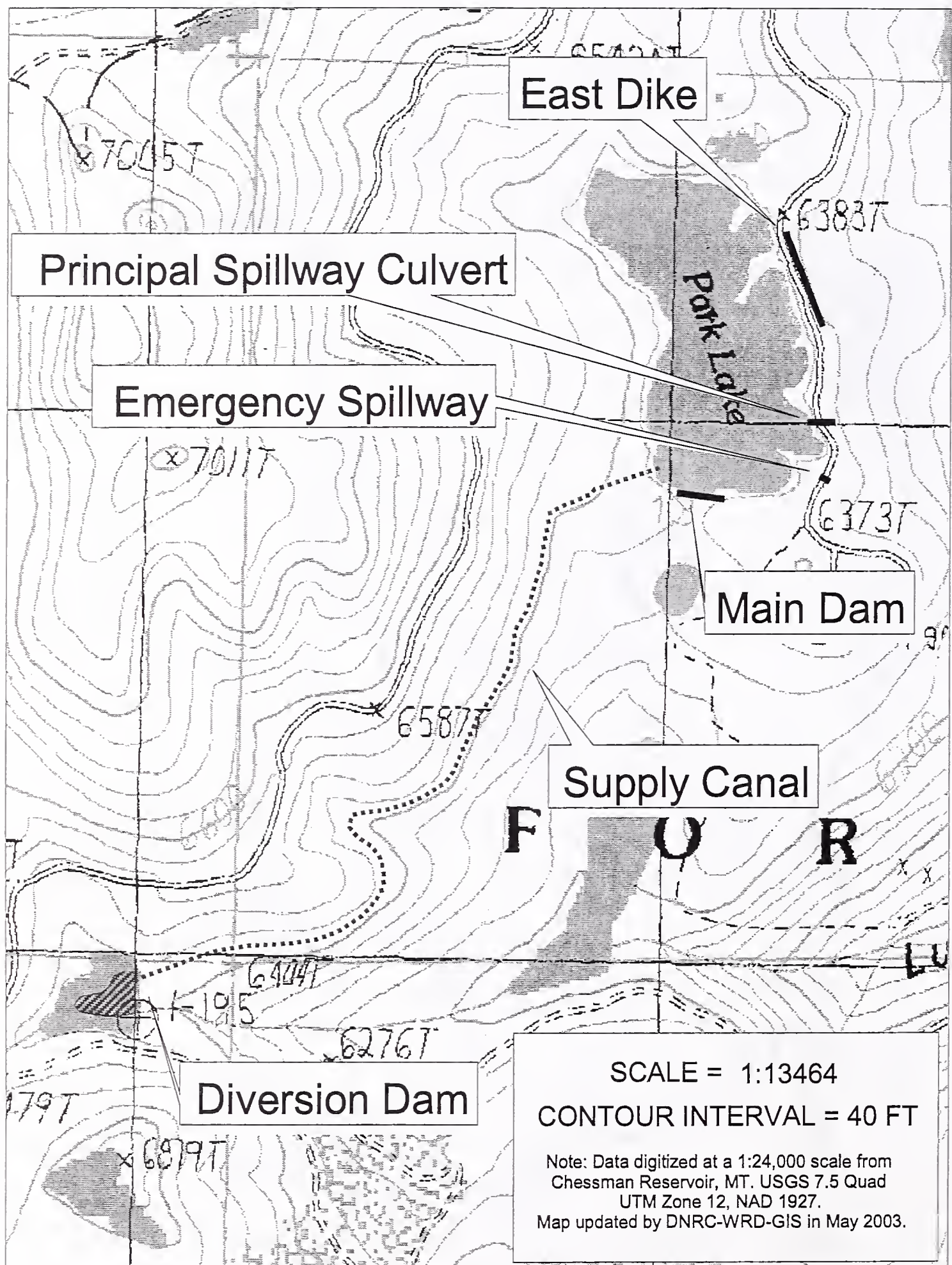


Figure 3. Park Lake Site Map

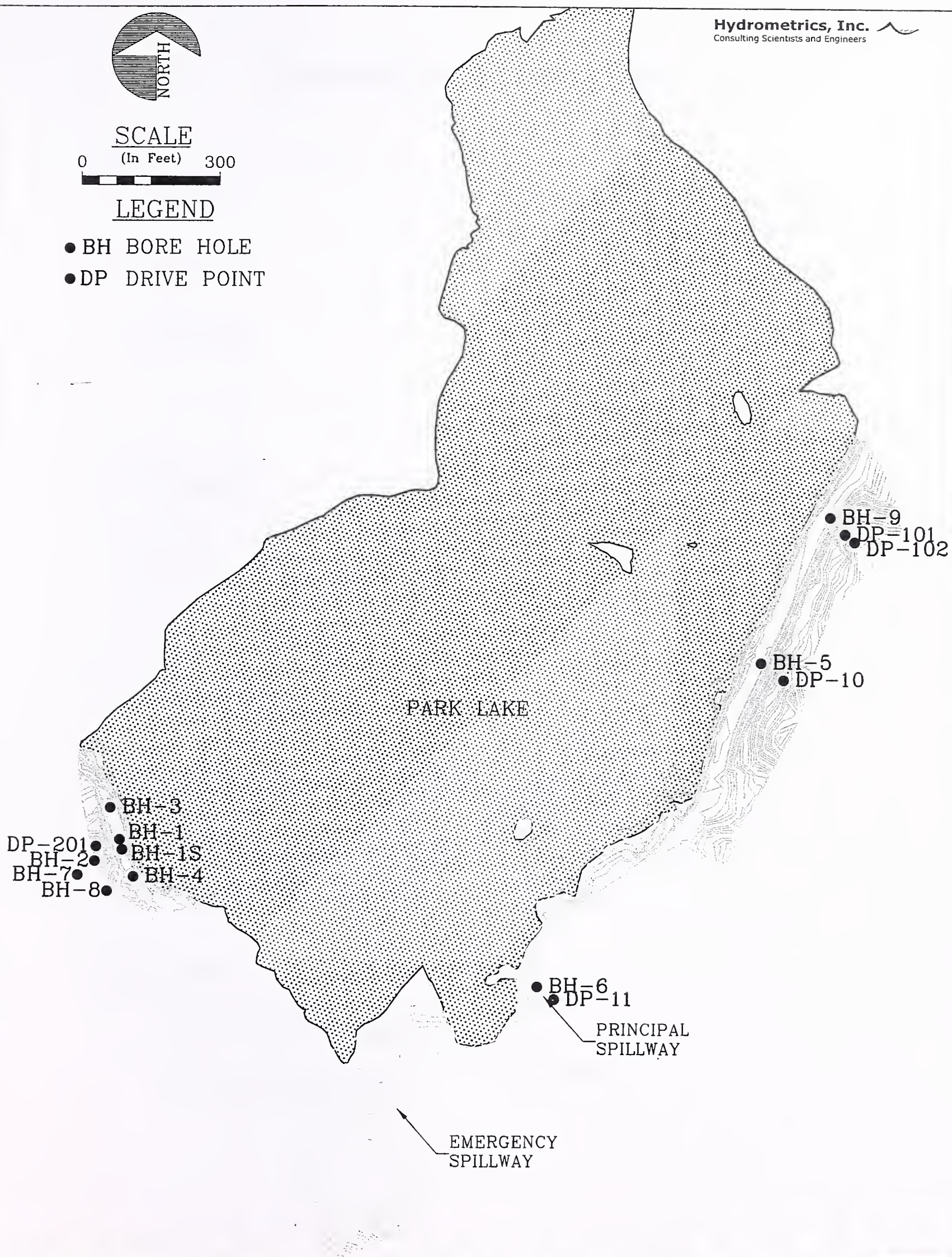


SCALE
(In Feet) 0 300

LEGEND

- BH BORE HOLE
- DP DRIVE POINT

Hydrometrics, Inc. 
Consulting Scientists and Engineers



PARK LAKE IMPROVEMENTS PROJECT
REPAIR ALTERNATIVES INVESTIGATION

PARK LAKE TOPOGRAPHIC SURVEY

FIGURE

1-1

Figure 4. Park Lake Monitoring Wells Location

STATISTICAL INFORMATION

1. General

- | | |
|-----------------------|-------------------------------------------------------------------------------------------------------|
| a. Owner | Montana Department of Fish, Wildlife, and Parks (DFWP) |
| b. Operator | Montana Department of Fish, Wildlife and Parks |
| c. Location | Sections 13, Township 8 North, Range 5 West, Montana Principal Meridian, 20 miles southwest of Helena |
| d. Latitude | 46.44° |
| Longitude | 112.17° |
| e. County--State | Jefferson - Montana |
| f. Watershed Location | Unnamed Tributary of Lump Gulch, Tributary of Prickly Pear Creek |
| g. Drainage Area | 0.48 square miles |
| h. Year Constructed | 1871 |

2. Principal Elevations (feet above mean sea level)

- | | |
|-----------------------------|--------------|
| a. Dam Crest | 6,361.5 feet |
| b. Emergency Spillway Crest | 6,359.4 feet |
| c. Principal Spillway Crest | 6,354.9 feet |

3. Reservoir

- | | |
|-------------------------------------------|------------|
| a. Length of Maximum Pool (approximately) | 1/2 mile |
| b. Surface Area (at normal full pool) | 37.5 acres |

4. Storage

- a. Total Storage 701 acre-feet
(pool at dam crest)
- b. Emergency Spillway 588 acre-feet
(pool at emergency spillway crest)
- c. Active Storage 389 acre-feet
(pool at principal spillway crest)
- d. Maximum Surcharge 312 acre-feet

5. Hydrology

- a. Inflow Design Flood 1,820 cfs
(Probable Maximum Flood -- PMF)
- b. 100 Yr Flood 28.5 cfs
- c. 500 Yr Flood 44.4 cfs

6. Embankment (Main Dam)

- a. Type Earthfill
- b. Hydraulic Height 21.6 feet
- c. Crest Length 350 feet
- d. Crest Width 10 to 25 feet
- e. Downstream Slope 1v on 1.5h
- f. Upstream Slope 1v on 1h

7. Dike (East Dike)

- a. Type Earthfill
- b. Hydraulic Height 19 feet
- c. Crest Length 2000 feet
- d. Crest Width 25 to 30 feet
- e. Downstream Slope 2v on 1h (estimated)
- f. Upstream Slope 2v on 1h (estimated)

8. Outlet Works --- none visible

9. Principal Spillway

- | | |
|------------------------------------|---------------------------------------------------|
| a. Location | South end of East Dike |
| b. Type | Corrugated metal arch pipe culvert (uncontrolled) |
| c. Size | 57" x 38"50 feet |
| d. Length | 53 feet |
| e. Capacity | 109 cfs |
| (pool at emergency spillway crest) | |

10. Emergency Spillway

- | | |
|-------------|--------------------------|
| a. Location | Southeast corner of lake |
| b. Type | Earthen (uncontrolled) |
| c. Length | 150 feet |
| d. Capacity | unknown |

OPERATING PROCEDURES

Park Lake is operated by the DFWP. The primary operating goal of the reservoir is to provide an adequate supply of water for fisheries and recreation without exceeding safe storage or flow levels.

DAM OPERATOR

The responsibility for the daily operation of the dam and reservoir rests with the DFWP and its dam operator. The dam operator is generally authorized to operate the reservoir to meet the DFWP's goals. The dam operator's specific responsibilities are to:

1. Coordinate filling of the reservoir
2. Measure monitoring wells and observe seepage
3. Notify the SWPB and DFWP of unusual occurrences such as impending floods, or excessive seepage.
4. Notify the SWPB and DFWP when spring runoff flows have peaked.
5. Perform maintenance tasks.

Typically, the out-going dam operator will train a new operator. The operator's training focuses on monitoring the supply canal, measurement of the storage level, measurement of the rate of water release, measurement of the monitoring wells and record keeping.

Communication between the dam operator, DFWP and SWPB is by telephone. Although not routinely available, radio communication may be established during emergencies or unusual occurrences, so the dam operator can speak directly with the SWPB (**see the Park Lake Dam Emergency Action Plan**). The SWPB will notify DFWP.

METHOD AND SCHEDULE OF OPERATION

The reservoir is operated for the purpose of maintaining the fishery and for recreation. The reservoir pool level is primarily maintained by diverting water from Lump Gulch through the supply canal. The reservoir is normally filled in the spring and early summer to the crest of the primary spillway (culvert). As summer progresses, flow in Lump Gulch decreases and inflow to the reservoir decrease. Because of evaporation, seepage and reduced inflows, the reservoir level typically drops by late summer, fall and winter.

SUPPLY CANAL

Monitor spring flows to assure the integrity of the diversion structure and the supply canal. The volume of inflow entering the ditch is controlled by stop-boards at the diversion structure. The estimated canal capacity is 5 cfs.

SPILLWAY

With the reservoir at the emergency spillway crest, the maximum capacity of the spillway using a head-discharge relationship is 109 cfs. A rating curve for the spillway is included in Appendix A.

In the event of heavy rainfall or runoff in the Park Lake basin, the reservoir should be inspected to insure the spillway is flowing freely, and its inlet is not submerged. If the culvert inlet is submerged, the culvert may be partially obstructed or is running at near its full capacity. In this situation, a DNRC engineer should be notified, and the lake level monitored until it drops. Stop boards may be placed in the division structure for the supply canal to eliminate additional inflows.

SAFE DRAWDOWN

Slope stability problems due to rapid drawdown of the reservoir are not likely due to the absence of an effective means (outlet structure) of lowering the reservoir. Drawdown can only be accomplished using a siphon, pump, or controlled breach.

STORAGE DETERMINATION

Storage in the reservoir and the elevation of the reservoir surface are determined by taking a slope measurement. Measure in feet from the 0+00 rebar pin to the water surface. The 0+00 pin is located at the southeast corner of the lake (south around the corner from the culvert overflow) near the reservoir side of the road. A green metal fence post marks the location of the 0+00 pin.

The measurement is made using a 100-foot tape. The tape should be stretched taut from the 0+00 pin to the edge of the water. Once the slope measurement is determined, the elevation of the reservoir surface and the storage can then be found using the Slope-Elevation-Storage Table (Table 1) in Appendix A.

INFLOW AND OUTFLOW MONITORING

Inflow to the reservoir is monitored by a staff gage located in the supply canal about 50 feet downstream of the Lump Gulch diversion structure. A rating table for this gage is included in Appendix A.

There is no outflow staff gage or measuring device for the reservoir. When water is flowing through the culvert (primary spillway), the depth can be measured using a tape measure on the upstream right hand side (looking downstream) of the culvert entrance.

WEATHER MONITORING

The dam operator monitors weather conditions, local weather forecasts, and the National Weather Service (NWS).

SNOTEL Sites: Current snow water equivalent and total precipitation can be monitored at a SNOTEL site located above the reservoir -- Frohner Meadow. The information for this site can be accessed under the Missouri Headwaters portion of the following USDA internet site:

<ftp://ftp.wcc.nrcs.usda.gov/data/snow/update/mt.txt>

Additional information about historical snowpack, precipitation, maps and graphs can be accessed at the following internet site:

<http://www.mt.nrcs.usda.gov/swcs/snow/snow.html>

INTERACTION WITH OTHER DAMS

The only dams located downstream of the Park Lake Dam are some small recreational ponds and irrigation diversion dams. The safety of these dams is not affected by the normal operation of Park Lake Dam. Therefore, interaction with other dams is not a concern of the normal operation of Park Lake Dam.

EMERGENCY

If it appears that the Park Lake Dam is about to breach, or during emergency operations, the dam operator will initiate the **Park Lake Dam Emergency Action Plan.**

INSPECTION AND MONITORING

The SWPB inspects the dam annually. Appendix B includes an example of a SWPB inspection report form. In addition to annual inspections, SWPB personnel or the dam operator will inspect the dam and reservoir during and after heavy runoff, severe rainstorms and severe windstorms; during high storage periods; and after an earthquake. The embankment is monitored by instrumentation.

STRUCTURAL FEATURES INSPECTION

Structural features include the supply canal, spillway, dam embankment, and East dike. The SWPB inspects these structures annually as part of its inspection program. Items to be checked or noted include, but are not limited to, the following:

1. Supply Canal
 - a. Condition of the diversion structure
 - b. Blockage of the approach channel (upstream of diversion structure)
 - c. Leakage or breaches in the canal
 - d. Wood debris, log jams, rock, or rock dams in canal channel
2. Spillway
 - a. Erosion of the spillway channel
 - b. Blockage of the approach or exit channel
 - c. Culvert condition
 - d. Erosion of the stilling basin area
3. Embankment and Dike
 - a. Erosion
 - b. Settlement, bulges, sink holes, cracking, misalignment
 - c. Riprap displacement

- d. Damage from burrowing animals
- e. Excessive vegetation, brush, trees
- f. Seepage
- g. Condition of the road across the dike

RIPRAP INSPECTION

There is no rip-rap or other upstream slope protection. Wave erosion has resulted in severe scarping (8 to 10 feet) of the upstream face.

DRAINS

There are no drains in the Main Dam embankment or the East Dike.

SEEPAGE

There are no reported or visible seepage areas on the dam embankment or immediately adjacent to the dam embankment. There is seepage which occurs at three locations on the downstream side of the East Dike.

MONITORING WELLS

Three hand driven shallow piezometers were installed by the SWPB in August, 1998 to begin understanding the seepage reservoir relationship. Two of these are located on the downstream toe at the north end of the East Dike. The third piezometer is at the downstream toe of the main dam embankment.

As part of a geotechnical site investigation to determine the work necessary to bring the dam up to present dam safety standards, a drilling program was performed by Hydrometrics in

September, 2001 to identify the soil profile and characteristics. Six borings were made on and around the dam and dike, and monitoring tubes placed in the drill holes. In September, 2002, five additional borings were made, and monitoring tubes placed in the drill holes. The location of the monitoring wells is shown in Figure 4. Copies of the well logs are in Appendix D.

SEEPAGE MONITORING

The monitoring wells and seepage areas at the dam are observed and monitored by the dam operator and the SWPB. Additionally, the wells may be measured by the SWPB during annual inspections. The instruments are generally measured once per month. The monitoring data is maintained by the SWPB in Helena.

EMBANKMENT MONITORING POINTS

There are no monitoring measurement points on the dam embankment or dike.

MAINTENANCE

The DFWP are responsible for the routine maintenance of the project. In addition, the SWPB may identify items that need maintenance or repair during the annual inspection.

ROUTINE MAINTENANCE

To protect the dam and keep it in good working order, the dam operator during regular visits to the dam will watch for and identify any potential maintenance requirements. As soon as a need is identified, the dam operator will contact the DFWP to schedule and perform the routine maintenance.

Items that may need occasional attention include, but are not limited to:

1. *Debris or silt plugging the spillway culvert.* Accumulated debris in the conduit and inlet area that could affect the operation of the culvert should be removed at once.
3. *Erosion gullies on embankment or dike.* Erosion gullies should be checked immediately. Gullies should be filled, compacted, and seeded. Particular attention should be paid to the groin/abutment contact areas.
4. *Rodent damage.* Rodents should be removed or destroyed, and any burrow holes should be filled immediately.
5. *Spillway slope riprap.* The upstream face riprap normally will be observed annually, but may occasionally need repairs because of high water or wave action. Riprap below spillway may need repairs.
6. *Vegetative cover on downstream embankment slope.* Good vegetative cover should be maintained. Large brush and any trees should be removed.

7. *Noxious weeds.* Noxious weeds on and around the dam embankment and around the reservoir shall be sprayed at least on an annual basis.

SUPPLY CANAL MAINTENANCE

Breaches in the ditch are to be repaired as quickly as possible to limit adverse downstream effects. This may require temporary repairs to be completed during the peak flows, with follow-up actions occurring after runoff has subsided.

ANNUAL MAINTENANCE

The SWPB conducts annual inspections of Park Lake Dam and reservoir. During these inspections, any items requiring annual maintenance will be identified and recorded. Items that may need annual maintenance are the dam embankment, spillway, supply canal, and riprap.

After the inspection, the SWPB sends the DFWP Helena Office a Dam Safety Inspection Report and a Maintenance Report. The reports identify items that need maintenance and provides a schedule of when the maintenance tasks need to be completed. The DFWP is responsible for performing the maintenance items within the times specified.

The DFWP may perform the maintenance tasks. However, major repair's will likely to be handled by a contractor. The SWPB may assist in contracting for repairs and may supervise the repair work.

RECORD-KEEPING

The SWPB maintains records, including photographs, of all inspections and maintenance requirements. These records also include flow measurements, storage volumes , and monitoring well

data. Anyone who wants to review these records may do so in the SWPB's office at the Department of Natural Resources and Conservation in Helena.

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APPENDICES

APPENDIX A
RATING CURVES AND TABLES

**TABLE 1. SLOPE- ELEVATION-STORAGE TABLE
PARK LAKE RESERVOIR**

Principal Spillway Crest 6,354.9 feet

Emergency Spillway Crest 6,359.4 feet

Dam Crest 6,361.5 feet

Based on bottom survey by Rob Kingery, DNRC (11/2001).

The 0+00 pin is located at the southeast corner of the lake near the reservoir side of the road.

DISTANCE feet	ELEVATION feet	STORAGE acre-feet		DISTANCE feet	ELEVATION feet	STORAGE acre-feet
Pin 0+00	6361.88			38	6353.17	320
1	6361.35	692		39	6353.06	315
2	6360.82	663		40	6352.95	311
3	6360.29	634		41	6352.90	309
4	6359.73	605		42	6352.88	308
5	6359.16	576		43	6352.86	307
6	6358.75	556		44	6352.83	306
7	6358.34	536		45	6352.81	305
8	6358.12	526		46	6352.75	303
9	6357.89	515		47	6352.68	300
10	6357.75	509		48	6352.61	297
11	6357.69	506		49	6352.48	292
12	6357.58	501		50	6352.34	287
13	6357.29	488		51	6352.29	285
14	6357.12	480		52	6352.24	283
15	6356.95	473		53	6352.13	278
16	6356.69	462		54	6352.01	274
17	6356.54	455		55	6351.94	271
18	6356.29	445		56	6351.87	269
19	6356.07	435		57	6351.80	266
20	6355.91	429		58	6351.68	262
21	6355.75	422		59	6351.60	259
22	6355.59	416		60	6351.51	256
23	6355.18	400		61	6351.45	254
24	6355.01	393		62	6351.39	252
25	6354.87	388		63	6351.34	250
26	6354.73	382		64	6351.29	249
27	6354.65	379		65	6351.26	248
28	6354.45	371		66	6351.23	247
29	6354.33	366		67	6351.20	246
30	6354.21	361		68	6351.16	245
31	6354.07	356		69	6351.16	244
32	6353.92	350		70	6351.15	243
33	6353.79	344		71	6351.09	242
34	6353.65	339		72	6351.03	240
35	6353.56	335		73	6350.96	237
36	6353.46	331		74	6350.88	235
37	6353.32	326				
DISTANCE	ELEVATION	STORAGE		DISTANCE	ELEVATION	STORAGE

TABLE 2. ACTIVE STORAGE IN ACRE-FEET

PARK LAKE DAM

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
6324										
6325	0.0									
6326	0.1									
6327	0.5									
6328	0.8									
6329	2	2	2	2	2	2	2	2	2	2
6330	3	3	3	3	3	3	3	3	3	3
6331	4	4	4	4	4	4	4	4	4	4
6332	5	5	5	5	6	6	6	6	6	6
6333	7	7	7	7	7	7	7	8	8	8
6334	8	8	9	9	9	10	10	10	10	11
6335	11	11	12	12	12	13	13	13	13	14
6336	14	14	15	15	16	16	17	17	18	18
6337	19	19	19	20	20	21	21	22	22	23
6338	23	24	24	25	25	26	27	27	28	28
6339	29	30	30	31	31	32	33	33	34	34
6340	35	36	37	37	38	39	40	41	41	42
6341	43	44	45	45	46	47	48	49	49	50
6342	51	52	53	55	56	57	58	59	61	62
6343	63	64	65	67	68	69	70	71	73	74
6344	75	77	78	80	81	83	84	86	87	89
6345	90	92	93	95	96	98	99	101	102	104
6346	105	107	109	111	113	116	118	120	122	124
6347	126	128	130	132	134	137	139	141	143	145
6348	147	150	153	156	158	161	164	167	170	173
6349	176	178	181	184	187	190	193	195	198	201
6350	204	207	211	214	218	221	225	228	232	235
6351	239	242	245	249	252	256	259	263	266	270
6352	273	277	281	285	289	293	297	301	305	309
6353	313	317	321	325	329	333	337	341	345	349
6354	353	357	361	365	369	373	377	381	385	389
6355	393	396	400	404	408	412	416	420	424	428
6356	432	436	441	445	449	453	458	462	466	471
6357	475	479	484	488	493	497	502	506	511	516
6358	520	525	530	534	539	544	549	553	558	563
6359	568	573	578	583	588	593	598	603	609	613
6360	619	624	630	635	640	646	651	656	662	667
6361	673	678	684	690	695	701				

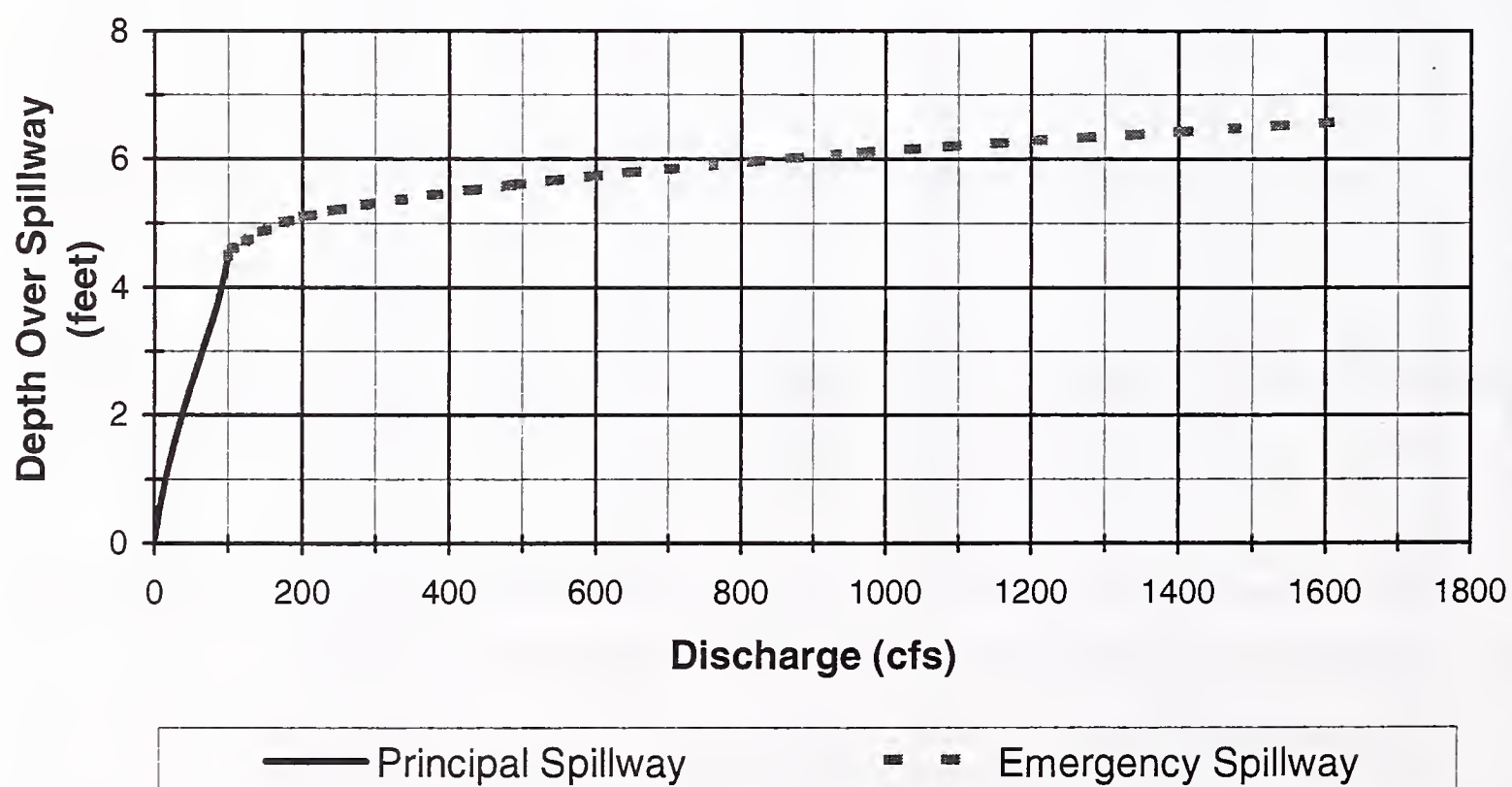
NOTE: Storage table data based on bottom survey by Rob Kingery, DNRC (11/2001).

Principal Spillway Crest	Elevation 6,354.9 feet	Storage 389 acre-feet
Emergency Spillway Crest	Elevation 6,359.4 feet	Storage 588 acre-feet
Dam Crest	Elevation 6,361.5 feet	Storage 701 acre-feet

**TABLE 3. SPILLWAY DISCHARGE
PARK LAKE DAM**

Depth Over Crest (feet)	Elevation (feet)	Principal Discharge (cfs)	Emergency Discharge (cfs)	Total Discharge (cfs)
0.00	6354.90	0		0
0.10	6355.00	0.6		1
0.60	6355.50	8.4		8
1.10	6356.00	17.3		17
1.60	6356.50	28.1		28
2.10	6357.00	40.2		40
2.60	6357.50	53.3		53
3.10	6358.00	66.8		67
3.60	6358.50	80.5		81
4.10	6359.00	91.6		92
4.50	6359.40	99.0	0	99
4.60	6359.50	100.9	3.1	104
5.10	6360.00	109.3	91.7	201
5.60	6360.50	117.2	367.8	485
6.10	6361.00	124.5	841.5	966
6.60	6361.50	131.5	1516.5	1648

**PARK LAKE DAM
SPILLWAY RATING CURVE**

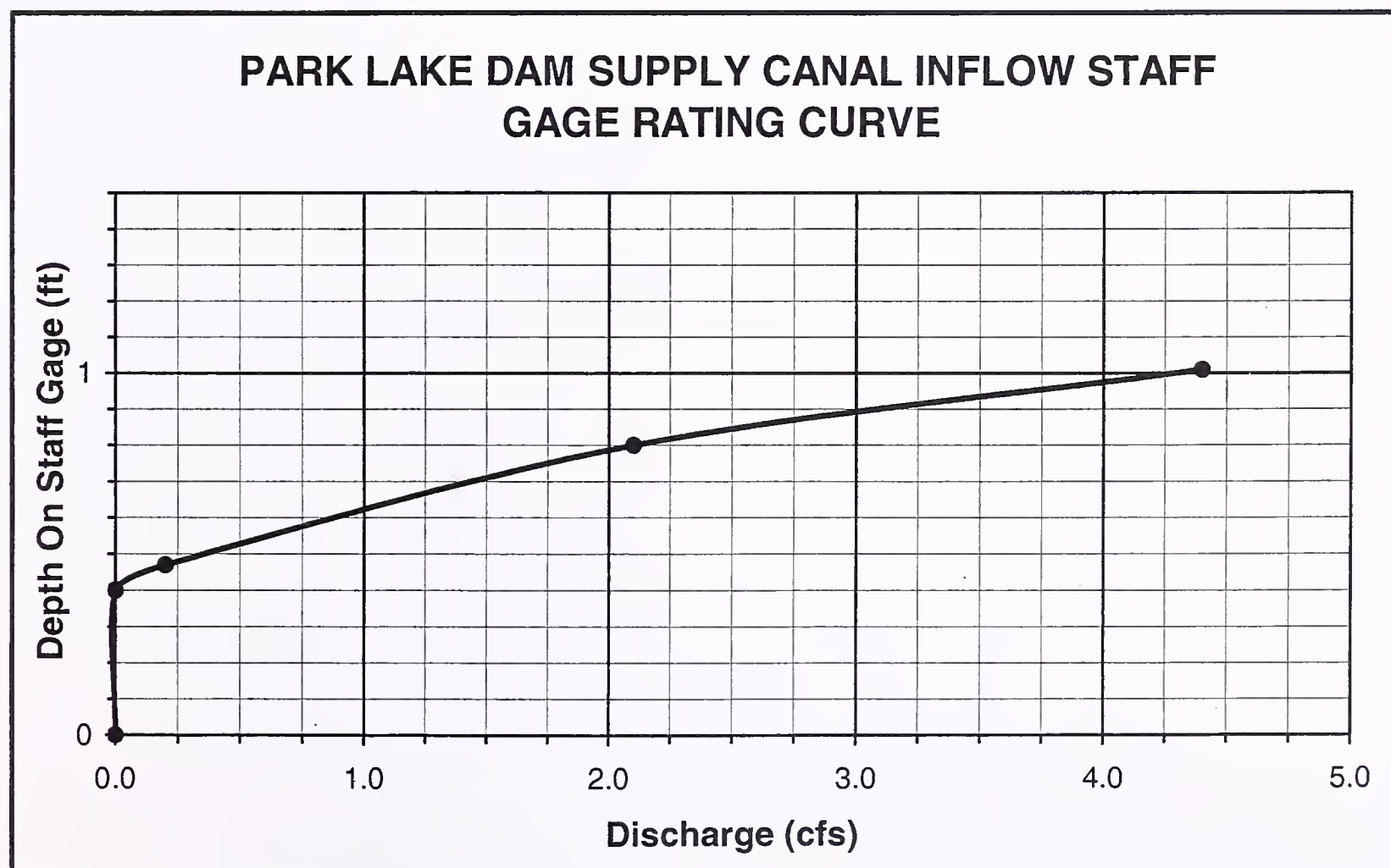


Note: Data from Rob Kingery, DNRC (1998).

TABLE 4. SUPPLY CANAL -- INFLOW STAFF GAGE

PARK LAKE DAM

Staff Gage (feet)	Discharge (cfs)
0.00	0.0
0.40	0.0
0.47	0.2
0.80	2.1
1.01	4.4



Note: Data from DNRC measurements (1999).

APPENDIX B
INSPECTION CHECKLIST

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM _____
DATE INSPECTED _____

INVENTORY NO. _____
HAZARD CATEGORY _____
TYPE OF DAM _____
YEAR BUILT _____

OWNER _____
OPERATOR _____
STREAM _____
DRAINAGE AREA _____

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection	_____	_____
At spillway crest	_____	_____
At min. dam crest elevation	_____	_____

ITEM	YES	NO	REMARKS
------	-----	----	---------

1. EMBANKMENT

A. Crest -- Height= Length= Width=

(1) Any visual settlements?			
(2) Any misalignments?			
(3) Any cracking?			
(4) Any traffic damage?			
(5) Other?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

1. EMBANKMENT (continued)

B. Upstream Face -- Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Is riprap protection adequate?			
(5) Any stone deterioration?			
(6) Any visual settlement, slumps, sloughing, depressions or bulges?			
(7) Adequate grass cover?			
(8) Debris on the dam face?			
(9) Other?			

C. Downstream Face--Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Any visual settlement, slumps, sloughing, depressions or bulges?			
(5) Is the toe drain dry?			
(6) Are the relief wells flowing?			
(7) Any boils at the toe?			
(8) Any seepage areas?			
(9) Any traffic or animal damage?			
(10) Any burrowing animals?			
(11) Adequate grass cover?			
(12) Other?			

D. Amount and Type of Vegetation on the Dam

--

ITEM	YES	NO	REMARKS
------	-----	----	---------

2. ABUTMENT CONTACTS

A) Any erosion?			
B) Any visual differential movement?			
C) Any cracks?			
D) Any seepage present?			
E) Other?			

3. OUTLET WORKS

A. Intake Structure -- Size=

(1) Any settlement?			
(2) Any tilting?			
(3) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(4) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(5) Metal appurtenances:			
a. Any corrosion present?			
b. Any breakage present?			
(6) Trash rack?			
a. Condition?			
b. Anchor system secure?			
(7) Other?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

3. OUTLET WORKS (continued)

B. Conduit -- Type = Size =

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Is the conduit metal?			
a. Any corrosion present?			
b. Protective coatings adequate?			
(4) Is the conduit misaligned?			
(5) Any calcium deposits?			
(6) Other?			

C. Gates and Tower

(1) Gates:			
a. Size: Operating:	Emergency:		
b. Type: Operating:	Emergency:		
(2) Controls operational?			
(3) Controls lubricated?			
(4) Operational problems?			
(5) Leakage around gates?			
(6) Condition of gate seals?			
(7) Any cavitation damage? If so, describe?			
(8) Describe air vent-size and condition.			

ITEM	YES	NO	REMARKS
------	-----	----	---------

3. OUTLET WORKS (continued)

C. Gates and Tower (continued)

(9) Is there a jet pump?			
a. Is it operational?			
b. Leakage?			
(10) Is the tower dry? ____ wet?			
(11) Any seepage in the tower?			
(12) Condition of the tower?			
(13) Any safety problems?			
(14) Ladder in good condition?			
(15) Condition of the gatehouse?			
(16) Emergency plan completed for the dam?			
a. Posted in the gatehouse?			
(17) Other?			

D. Stilling Basin

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Do energy dissipaters show:			
a. Signs of deterioration?			
b. Are they covered with debris?			
(4) Other?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:			
a. Eroding or backcutting?			
b. Sloughing?			
c. Obstructed?			
(2) Is released water:			
a. Undercutting the outlet?			
b. Eroding the embankment?			
(3) Other?			

4. SPILLWAY

A. Description

(1) Location?			
(2) Type of Spillway?			
(3) Size of Spillway?			
(4) Spillway lining?			
(5) Is there a weir?			
(6) Is the spillway in good condition?			
(7) Any drains?			
a. Describe the condition of drains.			

B. Does spillway show:

(1) Any cracking concrete?			
(2) Any spalling concrete?			
(3) Any exposed reinforcement in the concrete?			
(4) Any erosion?			

ITEM	YES	NO	REMARKS
------	-----	----	---------

4. SPILLWAY (continued)

4. B. Does spillway show: (continued)

(5) Any slope sloughing?			
(6) Any obstructions?			
(7) Displacement or offset joints?			
(8) Loss of joint material?			
(9) Leakage at the joints?			
(10) Other?			

C. Do the energy dissipaters show:

(1) Signs of deterioration?			
(2) Any cracking?			
(3) Any spalling?			
(4) Any exposed reinforcement?			
(5) Are they covered with debris?			
(6) Other?			

D. Has release water:

(1) Eroded the embankment?			
(2) Undercut the outlet?			
(3) Eroded the downstream channel?			
(4) Other?			

E. Emergency Spillway

(1) Is there an emergency spillway?			(If YES, describe)

ITEM	YES	NO	REMARKS
------	-----	----	---------

5. RESERVOIR CONTROL

A) Recent upstream development?			
B) Recent downstream development?			
C) Slides in reservoir area?			
D) Change in reservoir operation?			
E) Large impoundment upstream?			
F) Any debris in the reservoir?			
G) Other?			

6. INSTRUMENTATION

A) List type(s) of instrumentation:			
B) In good condition?			
C) Read periodically?			
D) Is data available?			
E) Include all data gathered since last report.			

7. DOWNSTREAM CONDITION

A. Downstream Land Use.

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This dam was inspected by:

Additional comments and recommendations.

APPENDIX C
DISTRUBUTION LIST

PARK LAKE DAM O&M DISTRUBUTION LIST

	<u>Number Of Copies</u>
1. State Water Projects Bureau Kevin Smith Rob Kingery FW&Ps Engineer (vacant) Art Taylor (2) Bob Arrington Dolores Eustice	7
2. DNRC Information Services Section	1
3. DNRC Helena Regional Office Jim Beck	1
4. DNRC Dam Safety	1
5. Department of Fish, Wildlife, and Parks Craig Marr – Helena, Park Operations Specialist Paul Valle – Helena – Design & Construction Bureau Chief Ken Phillips – Helena – Design & Construction Bureau	3
6. State Library – Attn: Roberta Gebhart	4
7. Extra	2
=====	
TOTAL	19

APPENDIX D

MONITORING WELL LOGS



HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Geotechnical Borehole

Hole Name: BH-1

Date Hole Started: 9/19/01 Date Hole Finished: 9/20/01

Client: Montana Dept. of Fish, Wildlife and Parks

Project: Park Lake Geotechnical

County: Lewis & Clark State: Montana

Property Owner: Montana Dept. of Fish, Wildlife and Parks

Legal Description: SW,SW,NE Sec13 T8N,R5W

Descriptive Location: Center of Park Lake dam at crest

Recorded By: John Ruth

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: ODEX

Drilling Fluids Used: Air

Purpose of Hole: Geotechnical Evaluation

Target Aquifer: First Water

Hole Diameter (in): 6"

Total Depth Drilled (ft): 37

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-30
Surface Casing Used?	Y	6-inch steel	+3 to -2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	20-30
Sand Pack?	Y	10-20 silica sand	18-37
Annular Seal?	Y	Bentonite Chips/Bentonite Grout	14-18 chips; 1-14 grout
Surface Seal?	Y	Concrete	0-1
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Drill cuttings and split spoon samples	

Static Water Level Below MP: 28.23

Date: 9/22/01

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.56

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 6362.92

MP Elevation (ft): 6365.48

Remarks: Depth water encountered: approx. 20'.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 5.0' Sand Brown, fine grain, well sorted, unconsolidated, slightly moist, trace fine gravel.
5	SS01	SS	6/12/11/10	1.80	5.0 - 7.0' SM: Gravel: 11% Sand: 72% Fines: 17% Well-graded, non-plastic. Corrected blowcount 15/21/26/23		5.0 - 7.0' Sand Brown, very fine grained, 15% silt, dry, loose, well sorted, 3% fine gravel.
10					10.0 - 12.0'		7.0 - 10.0' Sand As above.
15			50R				10.0 - 12.0' Sand As above.
15							12.0 - 15.0' Sand Brown, orange brown, very fine to fine grain, well sorted, slightly moist, trace very fine gravel.
20							15.0 - 20.0' Sand Orange brown, fine grain, well sorted, loose, cobble at 15', abundant black fragments, burnt wood?, trace fine gravel, wet at 20'.
20	SS03	SS	3/4/14/12	1.80	20.0 - 22.0' SM: Gravel: 4% Sand: 12% Fines: 24% Well-graded, non-plastic. Corrected blowcount 5/5/14/19		20.0 - 21.0' Sandy clay Brown, sticky, soft, wet, 25% fine to coarse sand.
25							21.0 - 22.0' Sand Black, white, medium to coarse grain, moderately sorted, weathered diorite fragments, loose, wet.
25		SS	3/7/11/10	1.70	25.0 - 27.0' SM/SP: Gravel: 1% Sand: 87% Fines: 12% Uniform, non-plastic. Corrected blowcount 4/7/12/14		22.0 - 25.0' Clayey sand Brown, orange brown, fine grained, clayey, soft, wet.
30							25.0 - 30.0' Sand Orange brown, fine grained, well sorted, soft, wet, clayey.
30	SS06	SS	2/4/6/8	1.80	30.0 - 32.0' SM: Gravel: 0% Sand: 64% Fines: 31% Well-graded, non-plastic. Corrected blowcount 2/4/6/8		30.0 - 31.0' Sand Brown, fine grained, well sorted, as above, wet.
35							31.0 - 32.0' Silt Brown, soft, slightly plastic, wet.
35							32.0 - 35.0' Sand Brown, fine grained, as above.
35	SS07	SS	5/10/13/14	1.90	35.0 - 37.0'		35.0 - 37.0' Sand Brown, fine grained, well sorted, loose, wet.
40							
45							

Client: Montana Dept. of Fish, Wildlife and Parks

Project: Park Lake Geotechnical

County: Lewis & Clark State: Montana

Property Owner: Montana Dept. of Fish, Wildlife and Parks

Legal Description: SW,SW,NE Sec13 T8N,R5W

Descriptive Location: Center of Park Lake
dam at crest

Recorded By: John Ruth

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: ODEX

Drilling Fluids Used: None

Purpose of Hole: Geotechnical Evaluation

Target Aquifer: First Water

Hole Diameter (in): 6"

Total Depth Drilled (ft): 18

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-17
Surface Casing Used?	Y	6-inch steel	+3 to -2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	12-17
Sand Pack?	Y	10-20 silica sand	10-18
Annular Seal?	Y	Bentonite Chips	1-10
Surface Seal?	Y	Concrete	0-1

DEVELOPMENT/SAMPLING

Well Developed? N

Water Samples Taken? N

Boring Samples Taken? N

Static Water Level Below MP: dry

Date: 9/22/01

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.79

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 6362.9

MP Elevation (ft): 6365.69

Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
							0.0 - 5.0' Sand Brown, fine grain, well sorted, unconsolidated, slightly moist, trace fine gravel.
5							5.0 - 7.0' Sand Brown, very fine grained, 15% silt, dry, loose, well sorted, 3% fine gravel.
							7.0 - 10.0' Sand As above.
10							10.0 - 12.0' Sand As above.
							12.0 - 18.0' Sand Brown, orange brown, very fine to fine grain, well sorted, slightly moist, trace very fine gravel.
15							
20							

HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Geotechnical Borehole

Hole Name: BH-2

Date Hole Started: 9/18/02 Date Hole Finished: 9/19/01

Client: Montana Dept. of Fish, Wildlife and Parks

Project: Park Lake Geotechnical

County: Lewis & Clark State: Montana

Property Owner: Montana Dept. of Fish, Wildlife and Parks

Legal Description: SW,SW,NE Sec13 T8N,R5W

Descriptive Location: Center of Park Lake dam at base

Recorded By: John Ruth

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: ODEX

Drilling Fluids Used: Air

Purpose of Hole: Geotechnical Evaluation

Target Aquifer: First Water

Hole Diameter (in): 6"

Total Depth Drilled (ft): 35

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-30
Surface Casing Used?	Y	6-inch steel	+3 to -2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	15-30
Sand Pack?	Y	10-20 silica sand	13-30
Annular Seal?	Y	Bentonite Chips/cement grout	9-13 chips
Surface Seal?	Y	Concrete	0-9

DEVELOPMENT/SAMPLING

Well Developed?	N
Water Samples Taken?	N
Boring Samples Taken?	Y Drill cuttings and split spoon samples

Static Water Level Below MP: 28.13

Date: 9/22/01

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.55

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 6345.26

MP Elevation (ft): 6347.81

Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
							0.0 - 3.0' Road fill Sand and gravel; brown, fine to coarse grain sand, fine to medium gravel, loose, dry.
							3.0 - 5.5' Boulder Diorite, black and white, finely crystalline, hard, brittle.
5	SS01	SS	8/9/10/11	1.70	5.5 - 7.5' SM/SW: Gravel: 6%; Sand: 83%; Fines: 11% Well-graded, non-plastic. Corrected blowcount 19/19/20/22		5.5 - 7.5' Sand Tan, very fine to fine grain, trace silty, trace medium to coarse grain sand, well sorted. 3-5% fine subrounded gravel, unconsolidated.
10							7.5 - 8.5' Sand As above, drive shelly tube. 8.0 - 10.0' Sand As above; attempt shelly tube at 10', but met immediate refusal; sand is slightly moist.
15							10.0 - 15.0' Sand As above, slightly moist, encounter water at 12', sand has 10% silt.
	SS02	SS	9/8/12/10	1.70	18.0 - 20.0' SM: Gravel: 6%; Sand: 64%; Fines: 30% Uniform, non-plastic. Corrected blowcount 13/12/14/16		15.0 - 18.0' Sand Collect shelly tube, sand as above, 10-15% medium to coarse grain, wet.
20							18.0 - 20.0' Sand Brown, very fine to fine grain, silty lenses with 10% silt, well sorted, trace fine to medium size gravel, wet.
							20.0 - 25.0' Sand Brown, fine grained, well sorted, unconsolidated, wet.
25							25.0 - 29.0' Sand Brown, medium to coarse grain, 25% fine grain, moderately sorted, loose, unconsolidated, wet.
30	SS03	SS	5/8/11/12	1.80	29.0 - 31.0' SM: Gravel: 1%; Sand: 81%; Fines: 18% Well-graded, non-plastic. Corrected blowcount 6/8/12/14		29.0 - 31.0' Sand Brown, fine grained, 3-inch horizons of medium to coarse grain, trace fine gravel.
							31.0 - 35.0' Sand Brown, as above, fine grained, wet, sloppy, no gravel.
35							
40							
45							



HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Geotechnical Borehole

Hole Name: BH-3

Date Hole Started: 9/22/01 Date Hole Finished: 9/22/01

Client: Montana Dept. of Fish, Wildlife and Parks

Project: Park Lake Geotechnical

County: Lewis & Clark State: Montana

Property Owner: Montana Dept. of Fish, Wildlife and Parks

Legal Description: SW,SW,NE Sec13 T8N,R5W

Descriptive Location: West side of Park Lake dam at crest

Recorded By: Mark Rhodes

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: ODEX

Drilling Fluids Used: Air

Purpose of Hole: Geotechnical Evaluation

Target Aquifer: First Water

Hole Diameter (in): 6"

Total Depth Drilled (ft): 30

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-30
Surface Casing Used?	Y	6-inch steel	+3 to -2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	20-30
Sand Pack?	Y	10-20 silica sand	18-30
Annular Seal?	Y	Bentonite Chips	1-30
Surface Seal?	Y	Concrete	0-1

DEVELOPMENT/SAMPLING

Well Developed?	N
Water Samples Taken?	N
Boring Samples Taken?	Y Drill cuttings and split spoon samples

Static Water Level Below MP: 29.77

Date: 9/23/01

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.54

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 6363.8

MP Elevation (ft): 6366.34

Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 5.0' Sand Light brown, fine to medium sand, trace fine gravel, trace siltballs, very loose, dry.
	SS01	SS	3/6/4/5	1.40	5.0 - 7.0' SM/SW: Gravel: 7%; Sand: 82%; Fines: 11%; Well-graded, non-plastic. Corrected blowcount 8/11/11/10		5.0 - 7.0' Sand Light brown, fine to medium sand, trace fine gravel, very loose, dry.
10							7.0 - 10.0' Sand Light brown, fine to medium sand, trace fine gravel, very loose, dry.
	SS02	SS	15/12/23/50R	1.30	10.0 - 12.0' SM/SP: Gravel: 33%; Sand: 56%; Fines: 11%; Uniform, non-plastic. Corrected blowcount 26/23/29		10.0 - 12.0' sand Top 9": brown, fine to medium sand, wet, loose. Next 4": gray, fine sand, 30% organic, 10% silt, loose, dry. Next 4": diorite rock fragments.
15							12.0 - 15.0' Cobbles Black and white, diorite, hard, brittle.
	SS03	SS	13/22/13/13/	1.50	15.0 - 17.0' SM: Gravel: 7%; Sand: 78%; Fines: 15%; Uniform, non-plastic. Corrected blowcount 21/28/27/20		15.0 - 17.0' Clayey sand Brown, fine to medium sand, 10% clay, firm, moist, trace fine gravel.
20							17.0 - 20.0' Sandy gravel Brown, medium sand, fine to medium gravel, loose, slightly moist.
		SS	R	0.00	20.0 - 22.0'		20.0 - 22.0' Cobbles Black and white, diorite, hard, brittle.
							22.0 - 25.0' Sandy gravel Brown, medium sand, fine to medium gravel, loose, slightly moist.
25							
	SS04	SS	8/12/10/7	1.50	25.0 - 27.0' SP: Gravel: 15%; Sand: 81%; Fines: 4%; Uniform, non-plastic. Corrected blowcount 11/14/15/12		25.0 - 27.0' Sand Light brown, fine sand, clean, trace fine gravel, moist, loose.
30							
		SS	1/1/2/3	0.00	30.0 - 32.0' Corrected blowcount 1/1/2/3		
35							
40							
45							

HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Geotechnical Borehole

Hole Name: BH-4

Date Hole Started: 9/23/01 Date Hole Finished: 9/23/01

Client: Montana Dept. of Fish, Wildlife and Parks

Project: Park Lake Geotechnical

County: Lewis & Clark State: Montana

Property Owner: USFS

Legal Description: SW,SW,NE Sec13 T8N,R5W

Descriptive Location: East side of Park Lake dam at crest

Recorded By: Mark Rhodes

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: ODEX

Drilling Fluids Used: Air

Purpose of Hole: Geotechnical Investigation

Target Aquifer: First Water

Hole Diameter (in): 6"

Total Depth Drilled (ft): 30

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-30
Surface Casing Used?	Y	6-inch steel	+3 to -2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	20-30
Sand Pack?	Y	10-20 silica sand	18-30
Annular Seal?	Y	Bentonite Chips	0-28
Surface Seal?	Y	Concrete	0-18

DEVELOPMENT/SAMPLING

Well Developed?	N
Water Samples Taken?	N
Boring Samples Taken?	Y Drill cuttings and split spoon samples

Static Water Level Below MP: dry

Date: 10/18/01

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.51

Surface Casing Height (ft): -2.8

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 6362.54

MP Elevation (ft): 6365.05

Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
0.0 - 5.0'							Sandy/roadfill Brown, fine to medium sand, trace firm gravel, dry, loose.
5.0 - 10.0'							Cobbles Fractured, diorite, black, white, hard, brittle.
10.0 - 12.0'	SS04	SS	3/4/3/4	1.80	10.0 - 12.0' SM: Gravel: 2%; Sand: 69%; Fines: 29%; Uniform, non-plastic. Corrected blowcount 5/6/6/6		Clayey sand Tan, very fine to fine sand, 5-10% clay, dry, slightly firm.
12.0 - 15.0'							Sand Brown, fine to medium sand, clean, very loose, dry (moisture in sample from drill rig).
15.0 - 17.0'	SS02	SS	6/13/13/9	1.80	15.0 - 17.0' SM: Gravel: 12%; Sand: 73%; Fines: 15%; Well-graded, non-plastic. Corrected blowcount 10/15/21/17		Sand Brown, fine to medium sand, clean, trace fine gravel, loose, slightly moist.
17.0 - 20.0'							Sand Brown, fine to medium sand, clean, trace fine gravel, loose, slightly moist.
20.0 - 22.0'	SS03	SS	3/4/4/6	1.80	20.0 - 42.0' CL/ML: Gravel: 0%; Sand: 6%; Fines: 94%; PI6, LL29. Corrected blowcount 8/9/10/12		Lean clay Top 6": Brown, fine to medium sand, clean, loose, slightly moist. Bottom 18": Brown clay, 35-40% sand, plastic, firm, moist.
22.0 - 25.0'							Sand Brown, fine to medium sand, clean, loose, moist.
25.0 - 27.0'	SS04	SS	3/4/6/8	1.70	25.0 - 27.0' ML: Gravel: 0%; Sand: 10%; Fines: 90%; PI3, LL27. Corrected blowcount 7/8/11/16		Silt Brown, clay, little to no sand, plastic, stiff.
27.0 - 30.0'							Silt As above.

HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Geotechnical Borehole

Hole Name: BH-5

Date Hole Started: 9/21/01 Date Hole Finished: 9/22/01

Client: Montana Dept. of Fish, Wildlife and Parks

Project: Park Lake Geotechnical

County: Lewis & Clark State: Montana

Property Owner: USFS

Legal Description: NE,SW,NE Sec13 T8N,R5W

Descriptive Location: North end of Park Lake dike along road

Recorded By: Mark Rhodes

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: ODEX

Drilling Fluids Used: Air

Purpose of Hole: Geotechnical Evaluation

Target Aquifer: First Water

Hole Diameter (in): 6"

Total Depth Drilled (ft): 27

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-25
Surface Casing Used?	Y	Flush	
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	15-25
Sand Pack?	Y	10-20 silica sand	13-25
Annular Seal?	Y	Bentonite Chips	9-13 chips
Surface Seal?	Y	Concrete	0-9

DEVELOPMENT/SAMPLING

Well Developed?	N
Water Samples Taken?	N
Boring Samples Taken?	Y Drill cuttings and split spoon samples

Static Water Level Below MP: 14.79

Date: 9/22/01

MP Description: Top of PVC

MP Height Above or Below Ground (ft): -0.85

Surface Casing Height (ft): 0

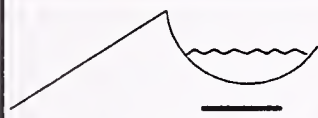
Riser Height (ft): -1.3"

Ground Surface Elevation (ft): 6363.05

MP Elevation (ft): 6362.2

Remarks: Depth water encountered: 20'.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
							0.0 - 3.0' Sand/road fill Brown, fine to medium sand; trace of coarse sand, very loose, moist, trace organic material.
5	SS01	SS	2/3/4/2/	1.40	5.0 - 7.0' SM/SW: Gravel: 8%; Sand: 82%; Fines: 10%; Well-graded, non-plastic. Corrected blowcount 5/6/8/7		3.0 - 5.0' Sand Brown, fine to medium sand, trace silt, trace fine gravel, fragments of crushed diorite, moist, loose.
10							5.0 - 10.0' Sand Brown, fine to medium sand, trace fine gravel, trace silt, very moist, very loose.
15	SS02	SS	9/4/29/30	1.10	12.0 - 14.0' SM: Gravel: 4%; Sand: 79%; Fines: 17%; Well-graded, non-plastic.		10.0 - 12.0' Sand Shelby, as above.
20	SS03	SS	3/3/2/1	0.80	15.0 - 17.0' SM: Gravel: 15%; Sand: 71%; Fines: 14%; Well-graded, non-plastic. Corrected blowcount 5/5/4/2		12.0 - 14.0' Silty Sand Dark brown, fine to medium sand, 5% clay, slight plasticity, very moist, slightly firm. Note: Bottom part of sample hit diorite cobble.
25	SS04	SS	4/7/11/9	1.40	20.0 - 22.0' SM: Gravel: 4%; Sand: 72%; Fines: 24%; Well-graded, non-plastic. Corrected blowcount 6/8/14/15		14.0 - 15.0' Silty Sand Same as above.
30	SS05	SS	5/5/15/10		25.0 - 27.0' SM: Gravel: 7%; Sand: 71%; Fines: 22%; Well-graded, non-plastic. Corrected blowcount 7/7/13/17		15.0 - 17.0' Organic silt Dark brown/black, fine to medium sand, 15% silt, 20% organics, very wet, very loose.
35							17.0 - 20.0' Organic silt Hit groundwater, as above.
40							20.0 - 22.0' Silty sand Reddish brown, fine to medium sand, 20% silt, trace coarse gravel, wet, firm.
45							22.0 - 25.0' Silty sand Brown, coarse to medium sand, loose, dry.
							25.0 - 27.0' Silty Sand Light brown, medium to coarse sand, clean, loose, 1" clay seam near 27'.



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Helena, Montana

Geotechnical Borehole

Hole Name: BH-6

Date Hole Started: 9/20/01 Date Hole Finished: 9/21/01

Client: Montana Dept. of Fish, Wildlife and Parks

Project: Park Lake Geotechnical

County: Lewis & Clark State: Montana

Property Owner: USFS

Legal Description: SE,SW,NE Sec13 T8N,R5W

Descriptive Location: South end of Park Lake dike along road

Recorded By: Mark Rhodes

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: ODEX

Drilling Fluids Used: Air

Purpose of Hole: Geotechnical Evaluation

Target Aquifer: First Water

Hole Diameter (in): 6"

Total Depth Drilled (ft): 25

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-25
Surface Casing Used?	Y	Flush	
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	15-25
Sand Pack?	Y	10-20 silica sand	13-25
Annular Seal?	Y	Bentonite Chips	9-13 chips
Surface Seal?	Y	Concrete	0-9

DEVELOPMENT/SAMPLING

Well Developed?	N
Water Samples Taken?	N
Boring Samples Taken?	Y Drill cuttings and split spoon samples

Static Water Level Below MP: 22.62

Date: 9/21/01

MP Description: Top of PVC

MP Height Above or Below Ground (ft): -0.84

Surface Casing Height (ft): 0

Riser Height (ft): -1.3"

Ground Surface Elevation (ft): 6361.66

MP Elevation (ft): 6360.82

Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 5.0' Sandy/road fill Brown, very fine to fine sand, trace coarse sand, trace very fine gravel, loose, moist, poorly graded.
5	SS01	SS	1/1/6/5	1.50	5.0 - 7.0' SM/SW: Gravel: 11%; Sand: 78%; Fines: 11%; Well-graded, non-plastic. Corrected blowcount 3/2/8/12		5.0 - 7.0' Silty Sand Brown, fine to medium sand, trace coarse sand, trace very fine gravel, loose, moist, wood fragments, trace clay; 5-5.5' medium sand; 5.5-7' fine to very fine sand.
10	SS02	SS	7/13/50R	0.60	10.0 - 12.0' GP: Gravel: 62%; Sand: 36%; Fines: 2%; Uniform, non-plastic. Corrected blowcount 12/17/		7.0 - 10.0' Sand Brown, very fine to fine sand, trace coarse sand, trace very fine gravel, loose, moist, poorly graded.
15	SS03	SS	7/13/12/9	0.40	15.0 - 17.0' SM/SW: Gravel: 10%; Sand: 80%; Fines: 10%; Well-graded, non-plastic. Corrected blowcount 11/16/20/16		10.0 - 12.0' Sandy gravel Brown, medium to coarse gravel, some fine to medium sand, loose, moist.
20							12.0 - 15.0' Silty sand Brown, fine to medium sand, 10% silt, loose, large boulder at 13'.
20							15.0 - 17.0' Gravelly Silty Sand Brown, coarse to medium gravel, fine to medium sand, loose, trace very fine sand.
25		SS	40/25/21/13	0.40	23.0 - 25.0' Corrected blowcount 36/132/24		17.0 - 20.0' Sand Brown, fine sand and fine gravel, very loose, slightly moist.
25							20.0 - 22.0' Sand Brown, tan, fine to medium sand, trace medium gravel, slightly moist.
25							22.0 - 25.0' Sandy gravel Brown, fine to medium sand, fine gravel, loose, moist, diorite cobble 22-23'.
30							
35							
40							
45							



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Helena, Montana

Geotechnical Borehole

Hole Name: BH-7

Date Hole Started: 9/3/02 Date Hole Finished: 9/4/02

Client: Montana Dept. of Fish, Wildlife and Parks
Project: Park Lake
County: Lewis & Clark State: Montana
Property Owner: United States Forest Service
Legal Description:
Descriptive Location:

Recorded By: Mark Rhodes
Drilling Company: O'Keefe Drilling
Driller: Steve Malkovich
Drilling Method: 6" Auger
Drilling Fluids Used: None
Purpose of Hole: Geotechnical Evaluation
Target Aquifer: None
Hole Diameter (in): 6"
Total Depth Drilled (ft): 90

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0-80
Surface Casing Used?	Y	6-inch steel	
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	68-78
Sand Pack?	Y	10-20 silica sand	64-80
Annular Seal?	Y	Bentonite Chips	3'-64'
Surface Seal?	Y	Concrete	0'-3'
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Grab	

Static Water Level Below MP: 20.66 Surface Casing Height (ft): 2.8
Date: 9/4/02 Riser Height (ft): 2.63
MP Description: Top of PVC Ground Surface Elevation (ft): 6341.71
MP Height Above or Below Ground (ft): +2.63 MP Elevation (ft): 6344.34

Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 4.8' Sand Tan, fine, little or no fines, dry, poorly graded, rounded.
5	SS01	SS	3/4/5/8	1.50	4.8 - 6.8'		4.8 - 6.8' Sand Tan, fine, little or no fines, dry, rounded, poorly graded.
10	SS02	SS	8/10/15/13	1.50	9.4 - 11.4'		6.8 - 9.4' Sand Same as above.
15	SS03	SS	5/7/6/9	1.50	14.4 - 16.4'		9.4 - 10.4' Sand Brown, very fine, 20-30% silt, moist.
20	SS04	SS	4/8/7/7	1.50	19.0 - 21.0' Problem with hammer, caused high BC.		10.4 - 11.4' Sand Tan, fine, little or no fines, dry, rounded, poorly graded.
25	SS05	SS	12/18/50	1.50	25.0 - 27.0'		11.4 - 14.4' Sand Tan, fine to medium, poorly graded, rounded, moist, same silt balls in upper 6".
30	SS06	SS	5/7/6/6	1.50	28.8 - 30.8'		14.4 - 17.4' Sand Tan, fine to medium, poorly graded, rounded, moist, little to no fines.
35	SS07	SS	1/2/1/2	1.50	34.0 - 36.0'		17.4 - 90.0' Sand Same as above. Hit water at 18'.
40	SS08	SS	1/2/4/7	2.00	40.0 - 42.0'		
45							
50							
55							
60							
65							
70							
75							
80							
85							
90							

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Geotechnical Borehole

Hole Name: BH-8

Date Hole Started: 9/4/02 Date Hole Finished: 9/5/02

Client: Montana Dept. of Fish, Wildlife and Parks
Project: Park Lake
County: Lewis & Clark State: Montana
Property Owner: United States Forest Service
Legal Description:
Descriptive Location:

Recorded By: Mark Rhodes
Drilling Company: O'Keefe Drilling
Driller: Steve Malkovich
Drilling Method: 6" Auger
Drilling Fluids Used: None
Purpose of Hole: Geotechnical Evaluation
Target Aquifer: None
Hole Diameter (in): 6"
Total Depth Drilled (ft): 90

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	
Surface Casing Used?	Y	6-inch steel	
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	48-58
Sand Pack?	Y	10-20 silica sand	45-59
Annular Seal?	Y	Bentonite Chips	3-46
Surface Seal?	Y	Concrete	0-3
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Grab	

Static Water Level Below MP: 27.09 Surface Casing Height (ft): 3.0
Date: 9/5/02 Riser Height (ft): 2.93
MP Description: Top of PVC Ground Surface Elevation (ft): 6348.18
MP Height Above or Below Ground (ft): +2.93 MP Elevation (ft): 6351.11

Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5	SS01	SS	2/5/7/12	1.50	3.6 - 5.6'		0.0 - 5.6' Sand Brown, medium to fine, 1% coarse sand, little to no fines, rounded, poorly graded, moist.
10	SS02	SS	12/8/6/7	1.50	8.6 - 10.6'		5.6 - 7.0' Sand Same as above. 7.0 - 8.0' Cobble Diorite cobble.
15	SS03	SS	4/5/5/7	1.50	13.8 - 15.8'		8.0 - 10.6' Sand Brown, fine to medium, 1% silt/rock flour, rounded, moist, some pieces of broken cobble.
20	SS04	SS	6/6/7/8	1.50	18.6 - 20.6'		10.6 - 12.0' Sand Brown, fine to medium, 1% medium gravel, rounded, little to no fines, poorly graded.
25	SS05	SS	4/4/4/3	1.50	23.6 - 25.6'		12.0 - 15.8' Sand Tan, fine, poorly graded, rounded, little to no fines, moist, loose.
30	SS06	SS	4/8/8/8	1.50	28.6 - 30.6'		15.8 - 20.6' Sand Same as above.
35	SS07	SS	2/4/4/4	1.50	33.6 - 35.6'		20.6 - 25.6' Sand Same as above. Hit water at 24' 8".
40	SS08	SS	1/1/2/5	1.50	39.8 - 41.8'		25.6 - 28.6' Sand Same as above.
45							28.6 - 29.6' Sand Tan, very fine, 30% silt, very wet.
50							29.6 - 30.6' Sand Brown, coarse, 10% fine gravel, loose, rounded, little to no fines, very wet, clean, poorly graded.
55							30.6 - 32.0' Sand Same as above.
60							32.0 - 35.6' Sand Tan, fine to medium, poorly graded, little to no fines, very wet, loose, rounded.
65							35.6 - 80.0' Sand Same as above.
70							
75							
80							
85							80.0 - 88.0' Sand Gray, fine to medium, angular, clean, no fines, poorly graded, very wet, loose.
90							

GEOTECH_REV1 2024.GPJ HYD-TUC.GDT 8/19/03

Client: Montana Dept. of Fish, Wildlife and Parks
Project: Park Lake
County: Lewis & Clark State: Montana
Property Owner: United States Forest Service
Legal Description:
Descriptive Location:

Recorded By: Mark Rhodes
Drilling Company: O'Keefe Drilling
Driller: Steve Malkovich
Drilling Method: 6" Auger
Drilling Fluids Used: None
Purpose of Hole: Geotechnical Investigation
Target Aquifer: None
Hole Diameter (in): 6"
Total Depth Drilled (ft): 34

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	0.4-34
Surface Casing Used?	Y	Flush Mount	
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	24-34
Sand Pack?	Y	10-20 silica sand	22-34
Annular Seal?	Y	Bentonite Chips	2-22
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Grab	







Static Water Level Below MP: 12.60 Surface Casing Height (ft): 0.0

Date: 9/5/02 Riser Height (ft): -.12

MP Description: Top of PVC Ground Surface Elevation (ft): 6359.31

MP Height Above or Below Ground (ft): -.12 MP Elevation (ft): 6359.19

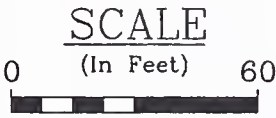
Remarks:

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
							0.0 - 4.0' Road Fill Brown, fine to medium sand, 20% fines, 5% small gravel, dry, loose, angular, well graded.
5							4.0 - 6.0' Sand Brown, medium, 40% gravel, 10% fines, angular, well graded, dry loose.
10							6.0 - 12.0' Sand Brown, fine to medium, 20% fines, 5% gravel, moist, angular, well graded.
15							12.0 - 19.0' Sand Brown, fine to medium, rounded, poorly graded, trace of silt, very wet. Hit water at 18'.
20							19.0 - 30.0' Sand Gray, fine to medium, 20-25% fines, clayey, slight plasticity, sticky, rounded, poorly graded.
25	SS01	SS	8/15/R	1.50	24.0 - 26.0' Spoon went crooked.		
30	SS02	SS	5/14/12/R	1.50	29.0 - 31.0' Spoon went crooked.		
35							30.0 - 35.0' Sand Brown, fine to medium, clean, rounded, poorly graded, loose, wet.
40							

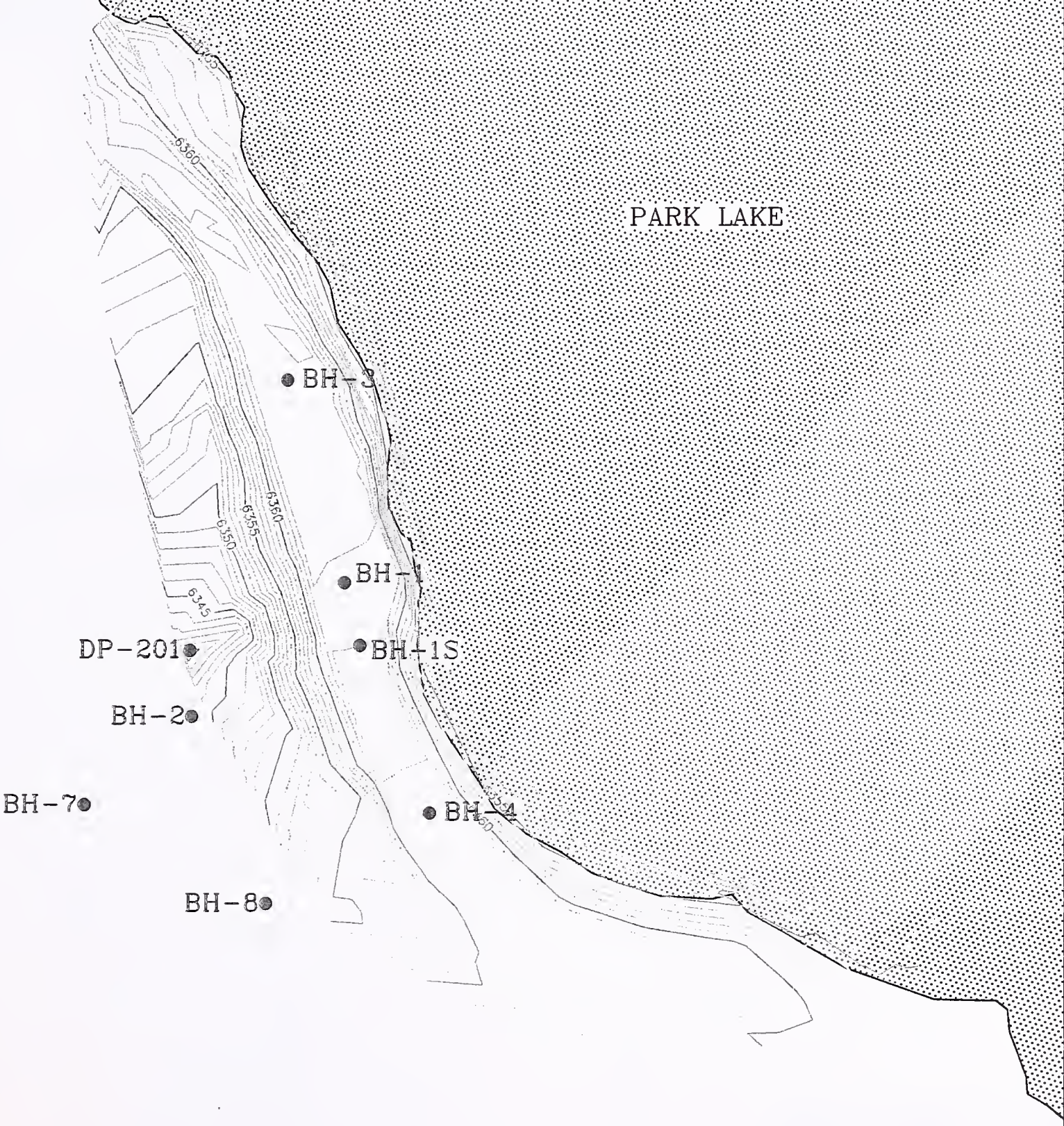
APPENDIX E

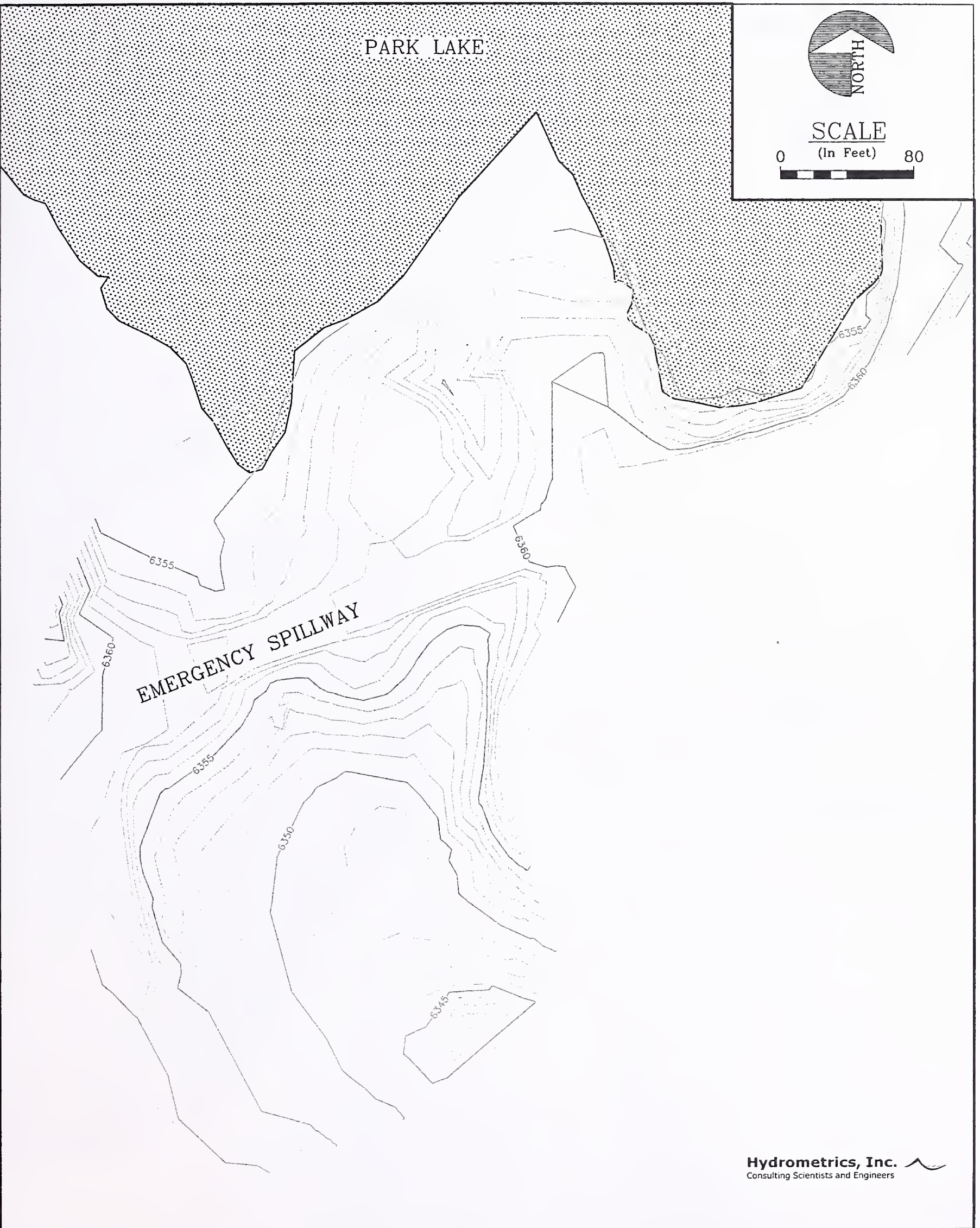
PROJECT DRAWINGS

(NOTE: A major rehabilitation of the dam and dike as well as replacement of the primary culvert spillway is planned for the Fall of 2004. Copies of the "As Builts" will be added following construction.)



- LEGEND
- BH BORE HOLE
 - DP DRIVE POINT



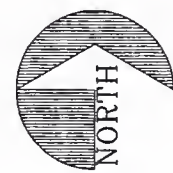


PARK LAKE IMPROVEMENTS PROJECT
REPAIR ALTERNATIVES INVESTIGATION

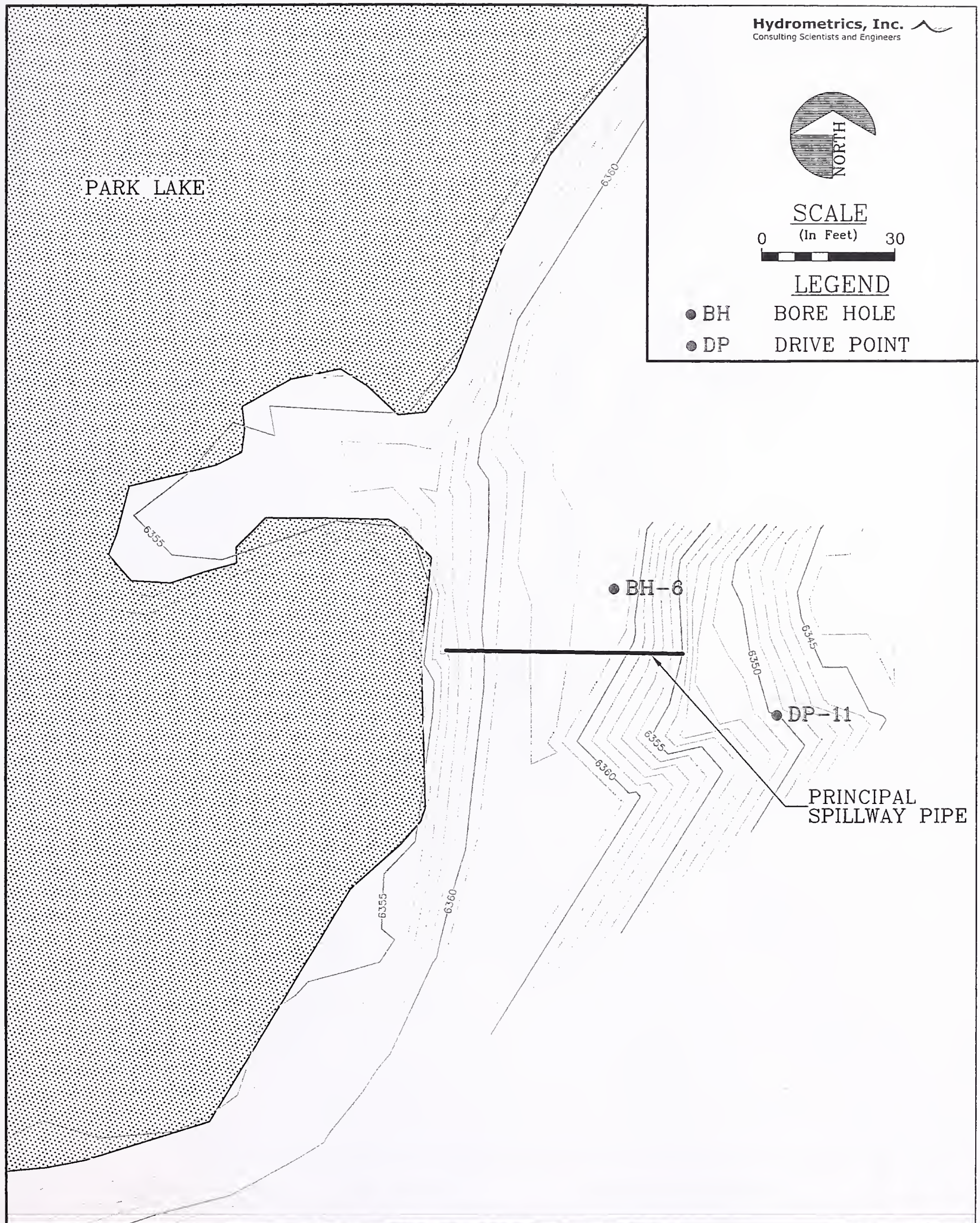
**PARK LAKE EMERGENCY
SPILLWAY TOPOGRAPHY**

FIGURE


H-2



- LEGEND**
- BH BORE HOLE
 - DP DRIVE POINT





SCALE
0 (In Feet) 120


LEGEND

- BH BORE HOLE
- DP DRIVE POINT



